Climate-induced changes in dissolved organic material influence contaminant exposure in aquatic systems

A Human Health Perspective

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Overview

BACKGOUND:

- Climate change influence on nutrients
- Nutrient influence on contaminants
  - -- anthropogenic
  - -- natural

CASE STUDY: DOC / Metals / UV

- Contaminants in the Great Lakes: predictions

Climate change influence on nutrient loading :

via….

Changes in the water regime

- ground water
- overland flow / run off
- changes in productivity

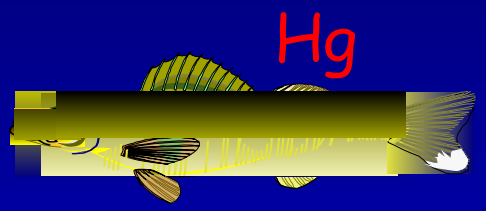
Land use changes

Ecological changes

- Changes in species composition

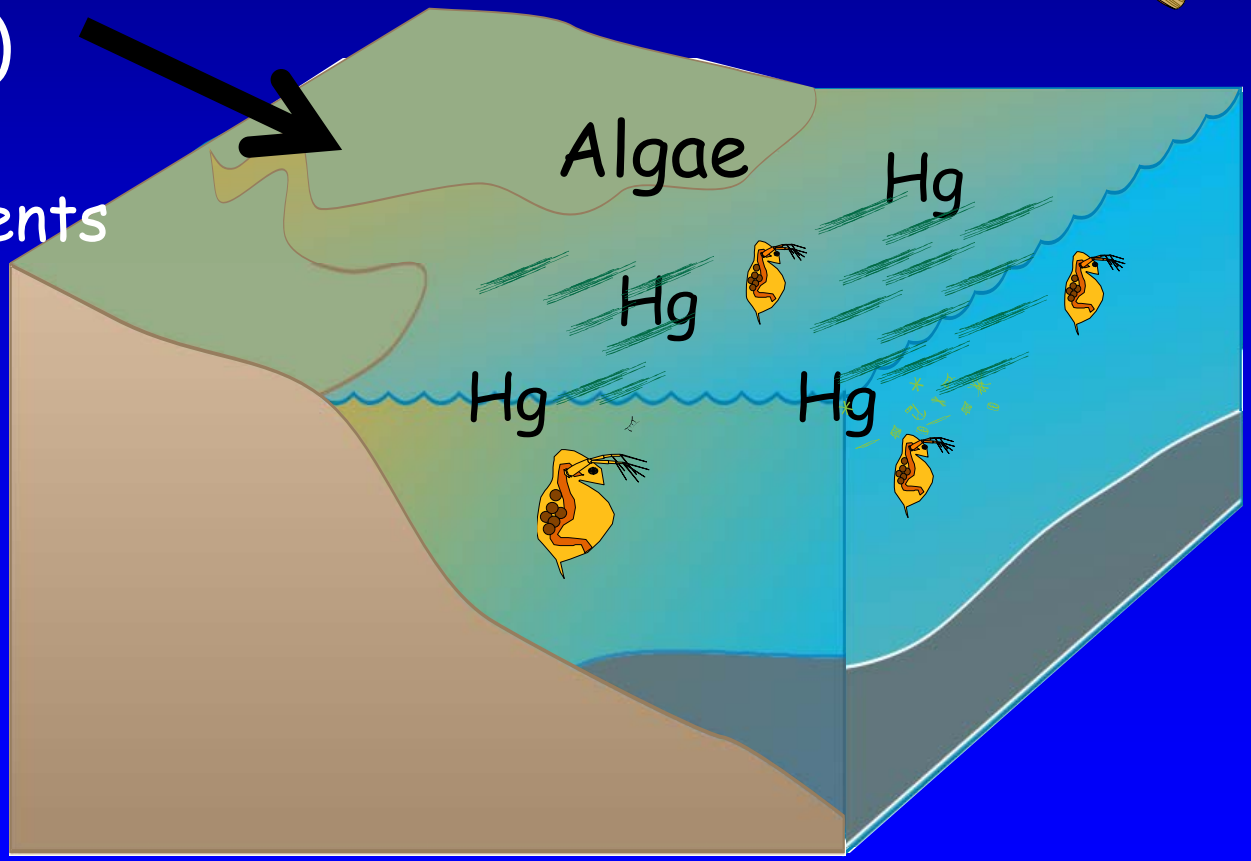
Agricultural runoff can carry sediment, nutrients and pesticides to surface waters. USDA Soil Conservation Service

Influence of nutrient loading on contaminant levels in fish



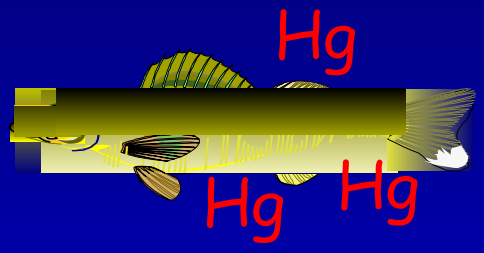
Nutrients
(N, P)

High Nutrients



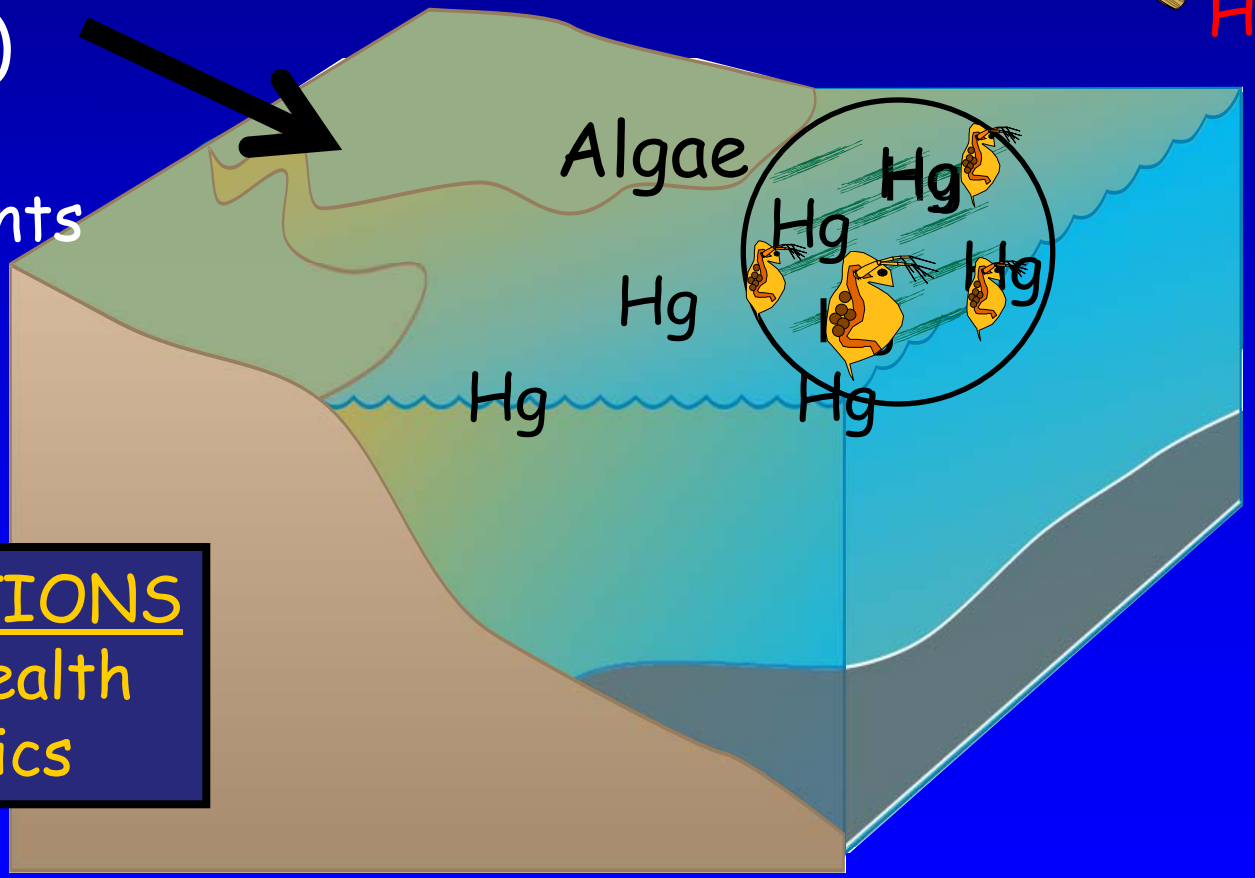
Folt et al

Influence of nutrient loading on contaminant levels in fish



Nutrients
(N, P)

Low Nutrients



IMPLICATIONS
Human health
Economics

Folt et al

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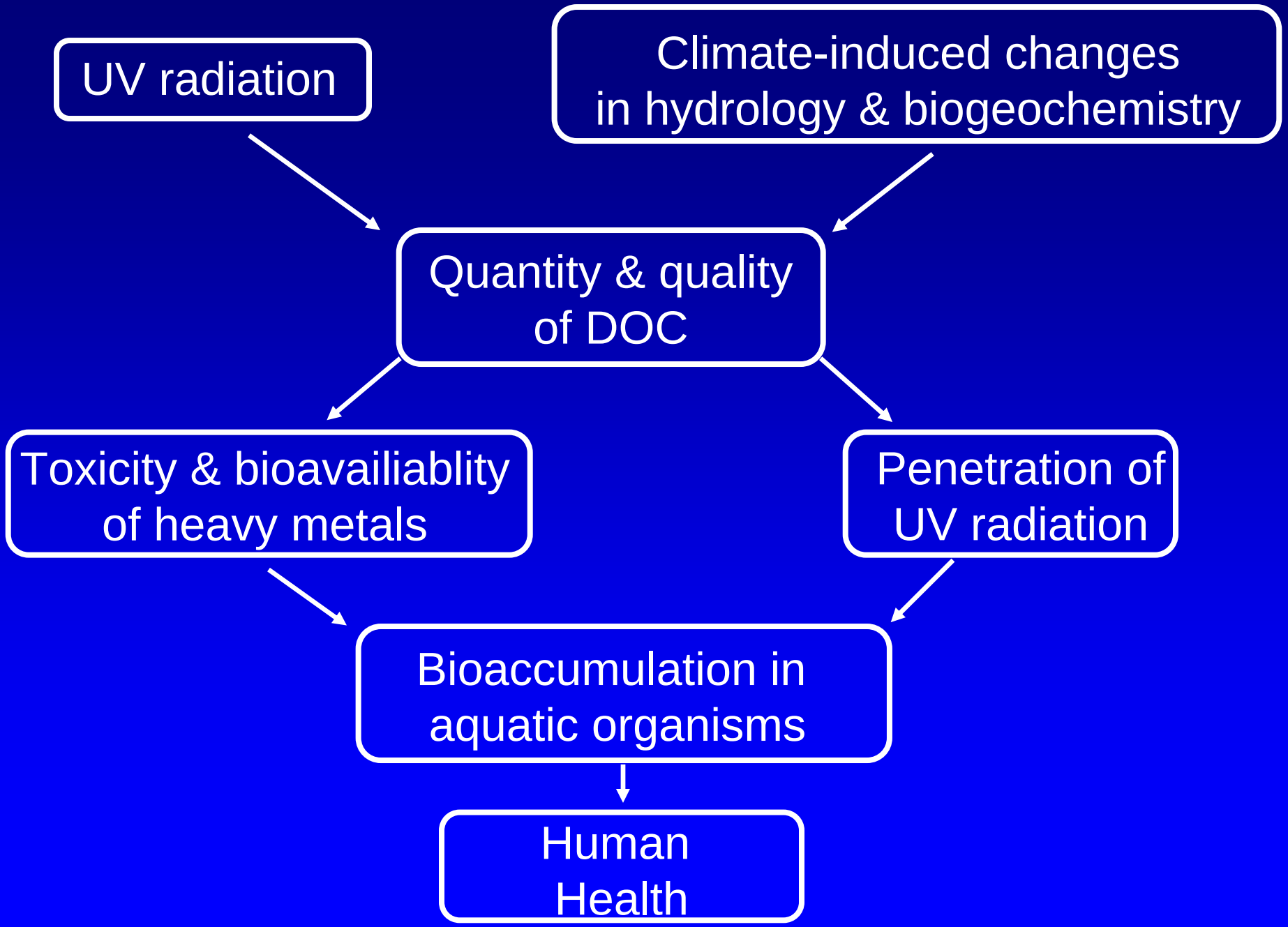

UV radiation
Climate-induced changes in hydrology & biogeochemistry
Quantity & quality of DOC
Toxicity & bioavailiablity of heavy metals
Penetration of UV radiation
Bioaccumulation in aquatic organisms
Human Health

Case Study

Assess the independent and interactive effects of UV radiation, dissolved organic carbon, and metals on aquatic benthic communities

[DOC + Zn] < Zn < [UV+DOC+Zn] ≈ [UV + Zn]

Hypothesized stress increase

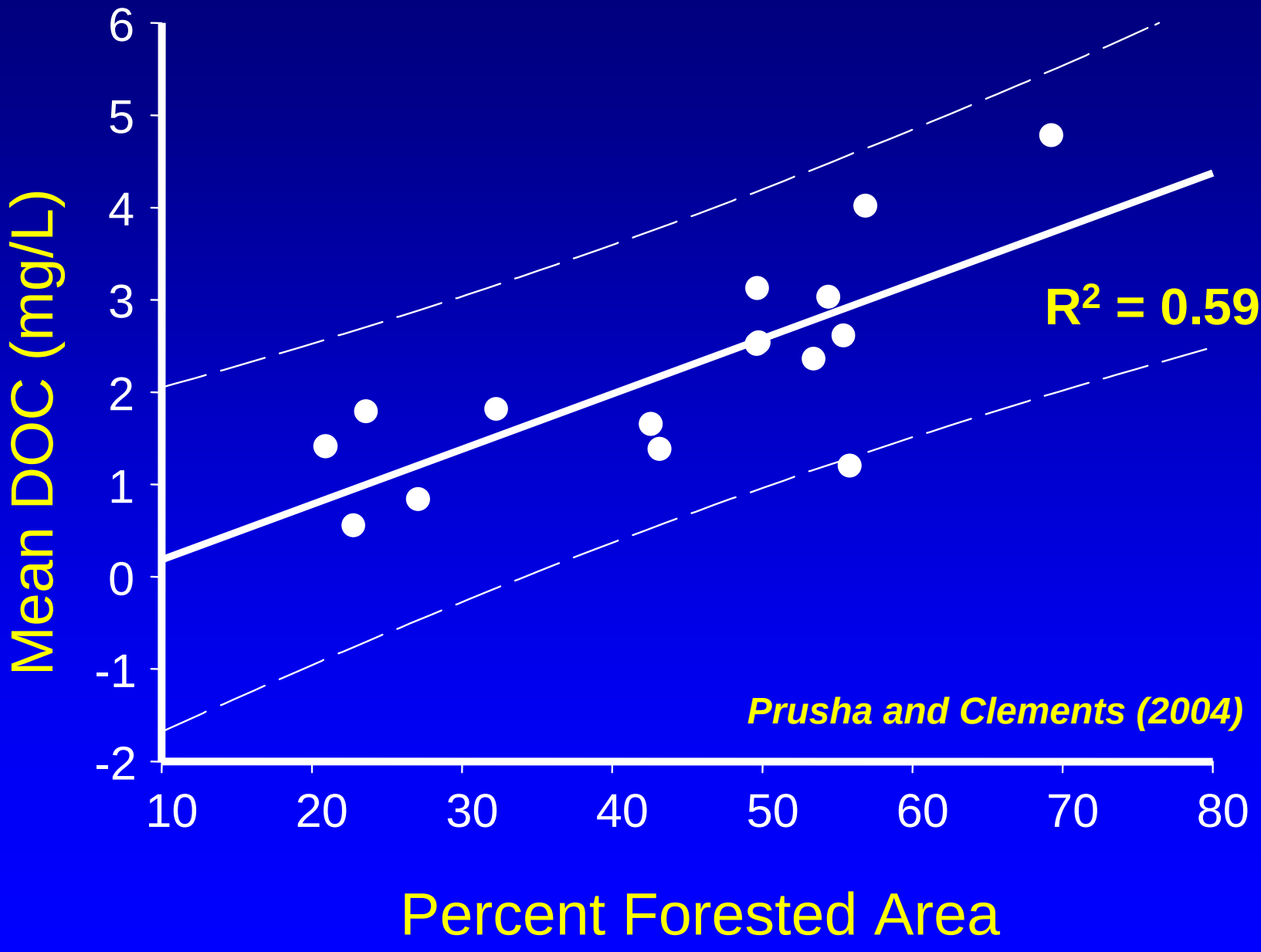
Laboratory
Microcosm experiments

Colorado and New Zealand

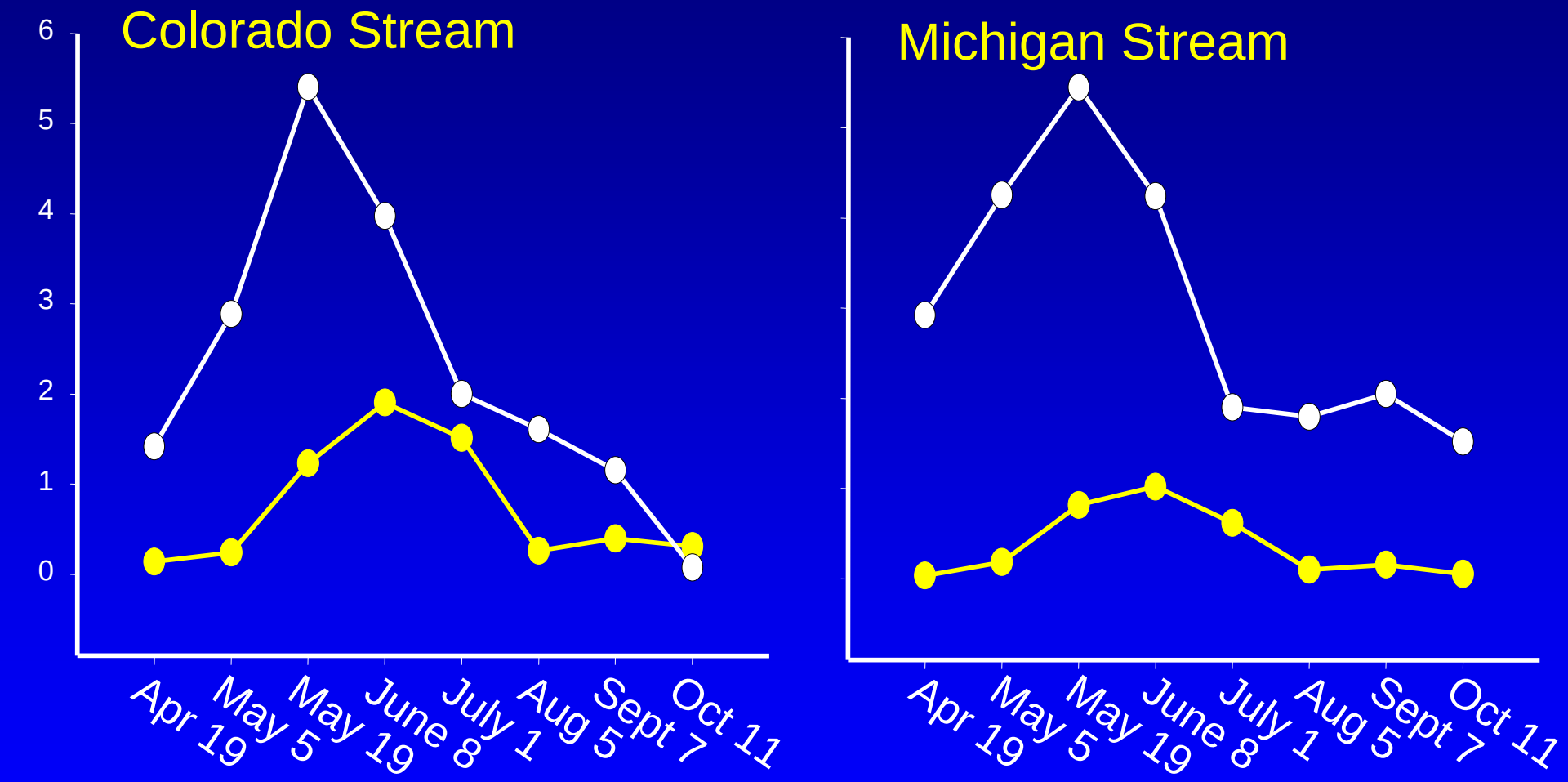
Field
experiments
&
monitoring

Colorado and Michigan

Case Study: Monitoring

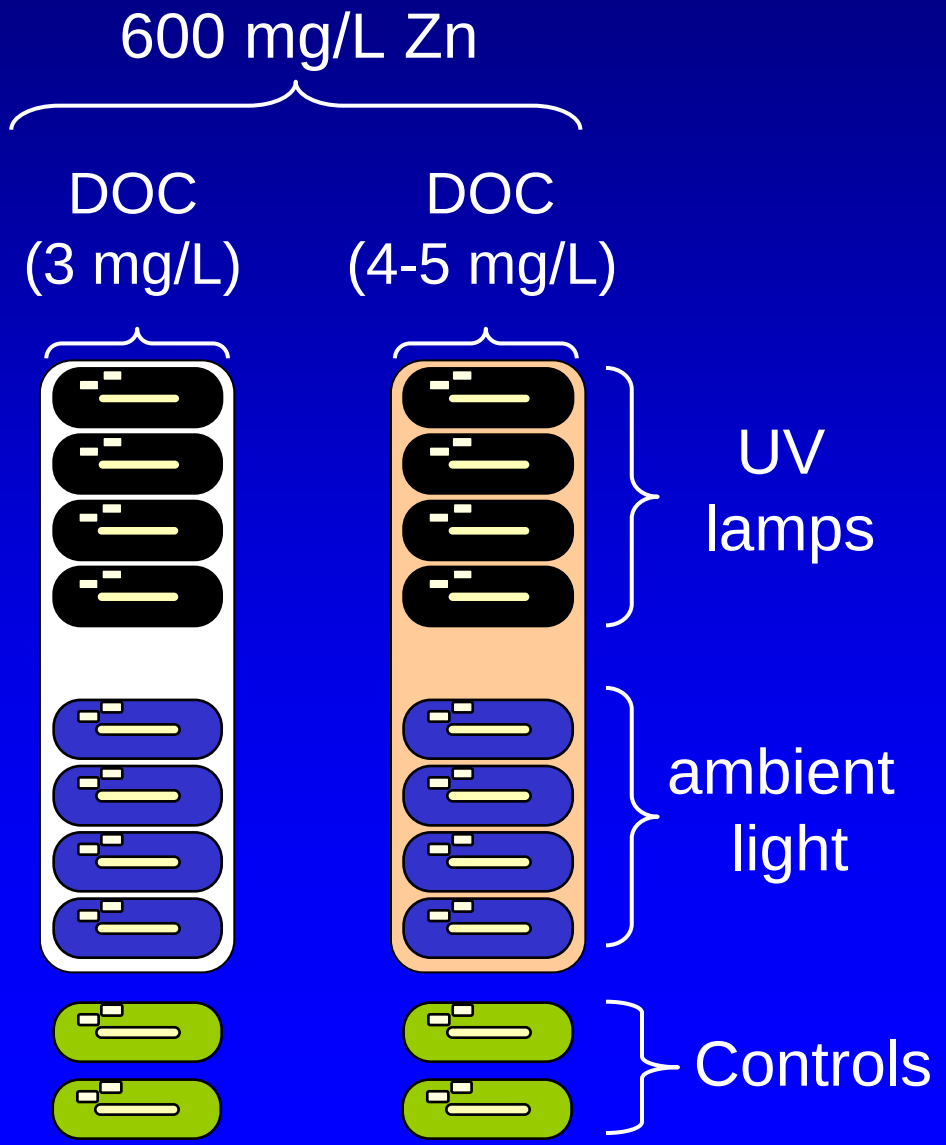


Relationship among discharge, DOC and time

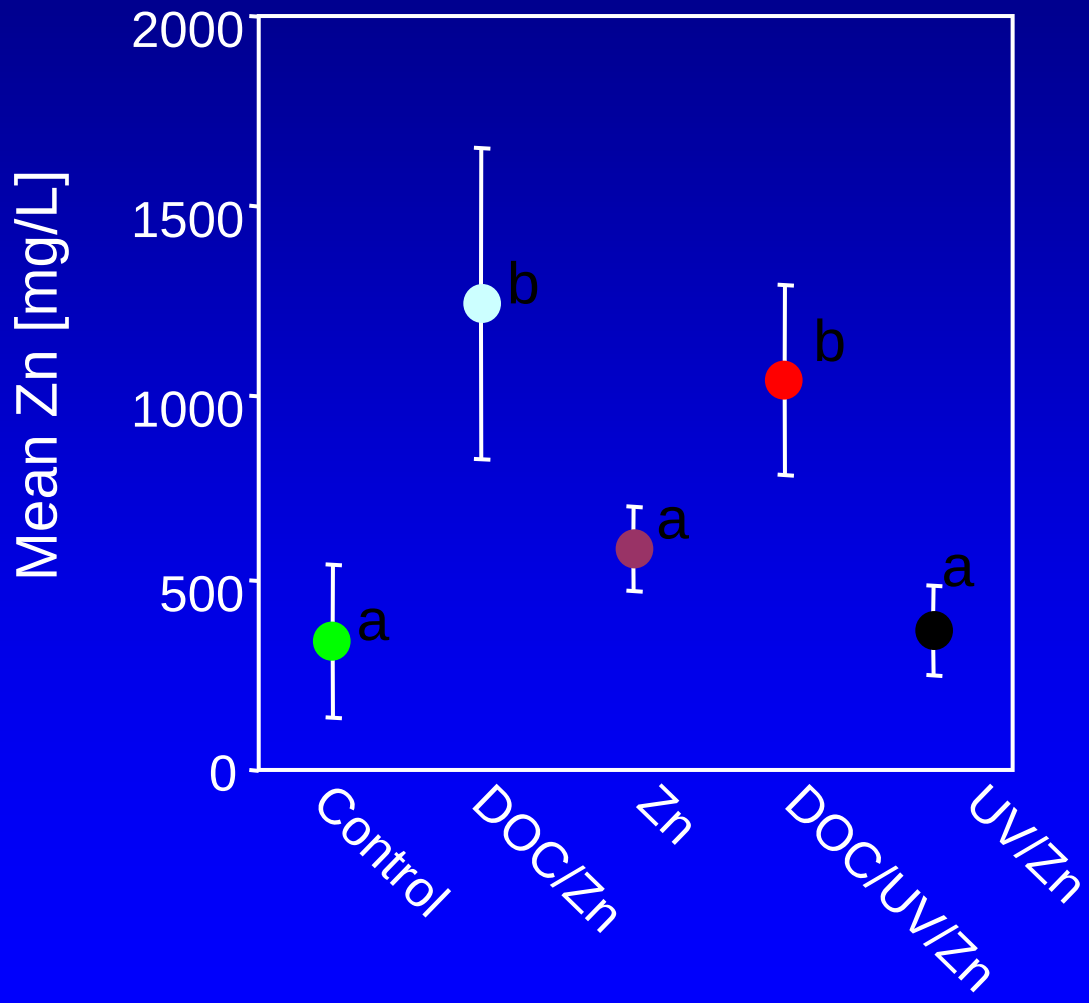


Case Study: Microcosm Experiments

- DOC + UV + Zn
- Zn + DOC
- Zn
- UV + Zn
- Control



Microcosm : Zn accumulation in algae



ANOVA: $p < 0.05$

Summary

- DOC increased with discharge & vegetation
- DOC strongly influenced UV-B attenuation
- DOC did not mitigate Zn toxicity

Implications

- Climate-induced changes in DOC are likely to increase UV-b exposure & metal bioavailability

Nutrient influence on contaminants **(natural)**

Harmful Algal Blooms

- Fish kills
- Pet deaths
- Recreational exposure
  - skin irritant
  - inhalation
- Drinking water
  - Human health

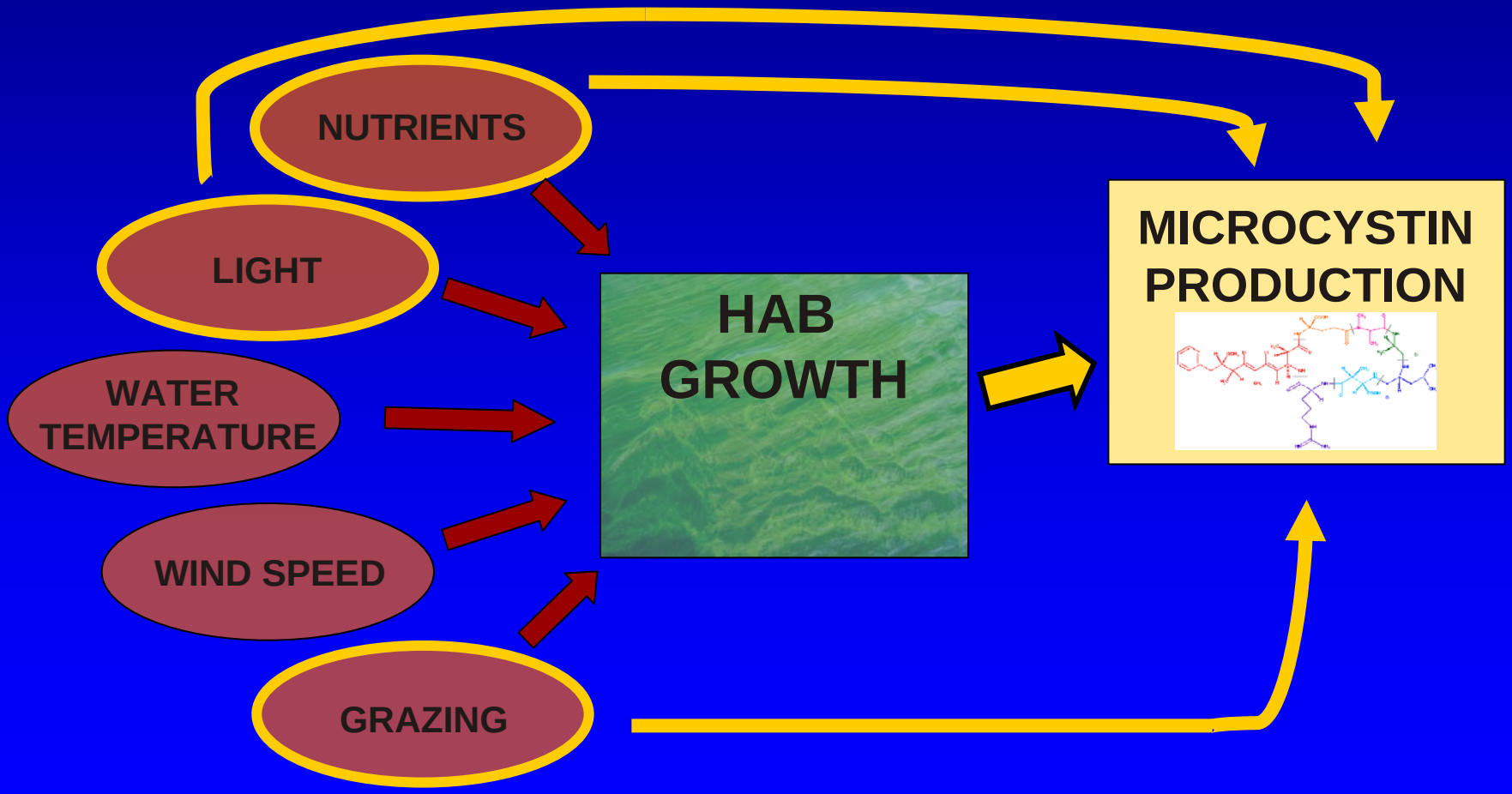
“A link exists between global warming and the worldwide proliferation of harmful cyanobacterial blooms” *(Pearl and Huisman 2008)*

Neuse River Estuary,
North Carolina, USA

Lake Victoria, Africa

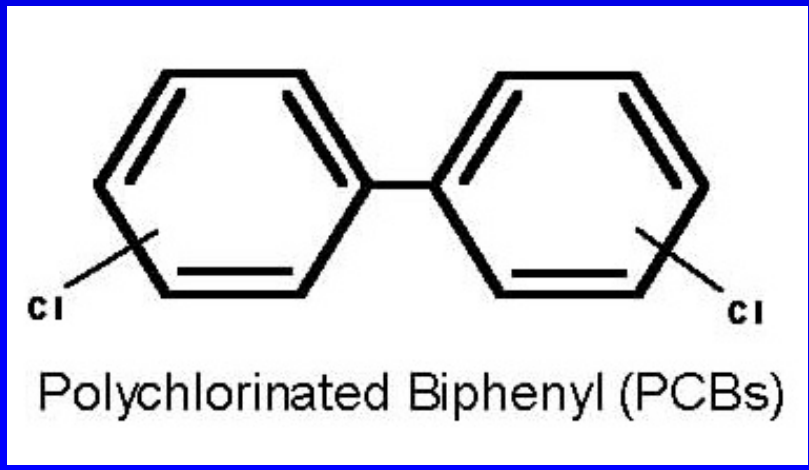
Science 2008

Environmental factors influencing growth and toxin production in *Microcystis*



Contaminants in the Great Lakes: predictions

- Lower water levels and warmer temperatures may accelerate the accumulation of Hg and other contaminants in the food chain, ultimately affecting human health.
- Increased storm frequency may stir up PCBs and warmer temperatures may vaporize these volatile chemicals creating more air pollution.

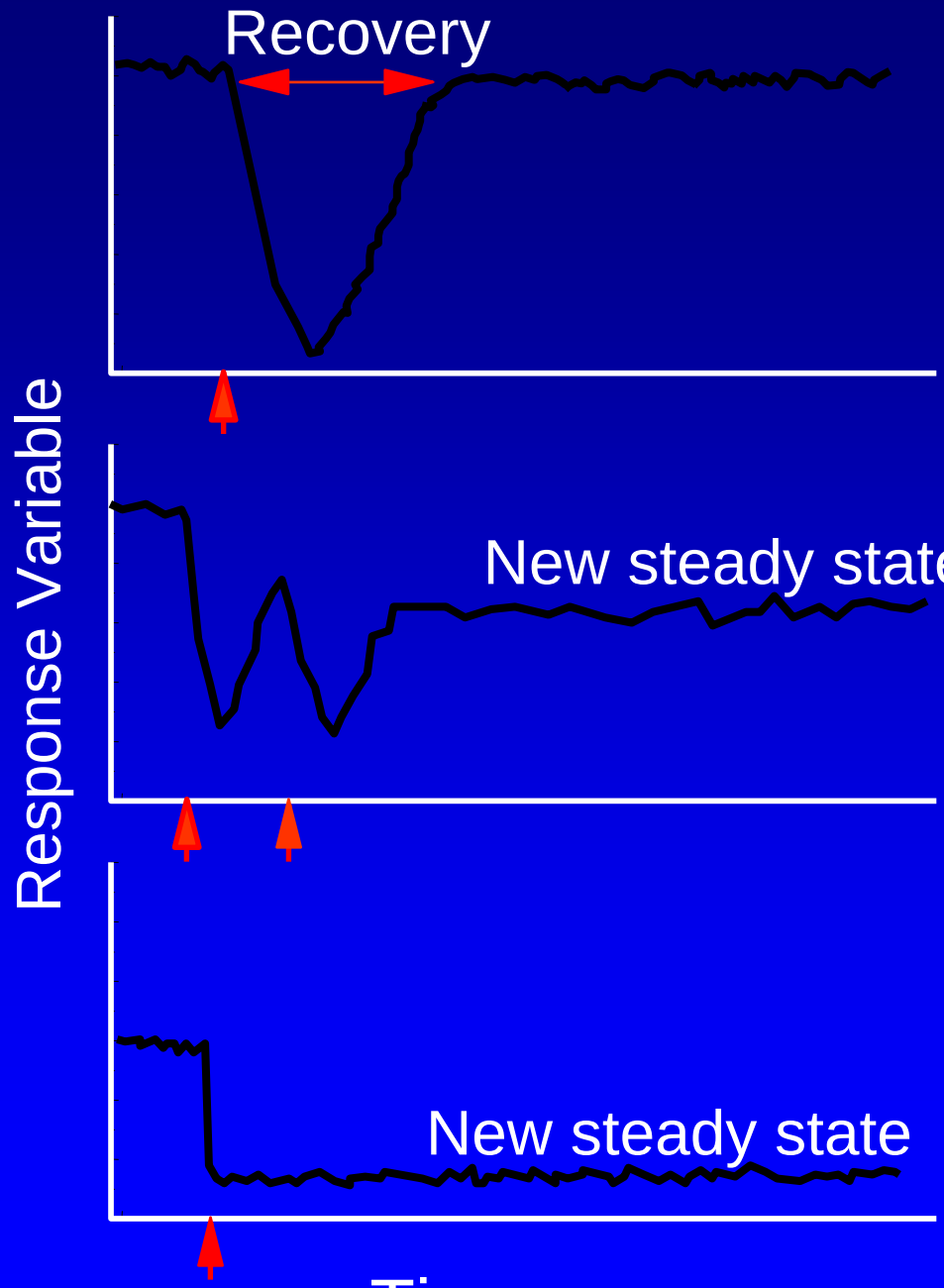


Polychlorinated Biphenyl (PCBs)

Future Research
(many unknowns and research needs)

Determine the role of water levels, wave action, water temperature, nutrient loads on contaminant exposure (natural and anthropogenic) on air quality, water quality, biota…..

Multiple stressors / Compound Disturbances



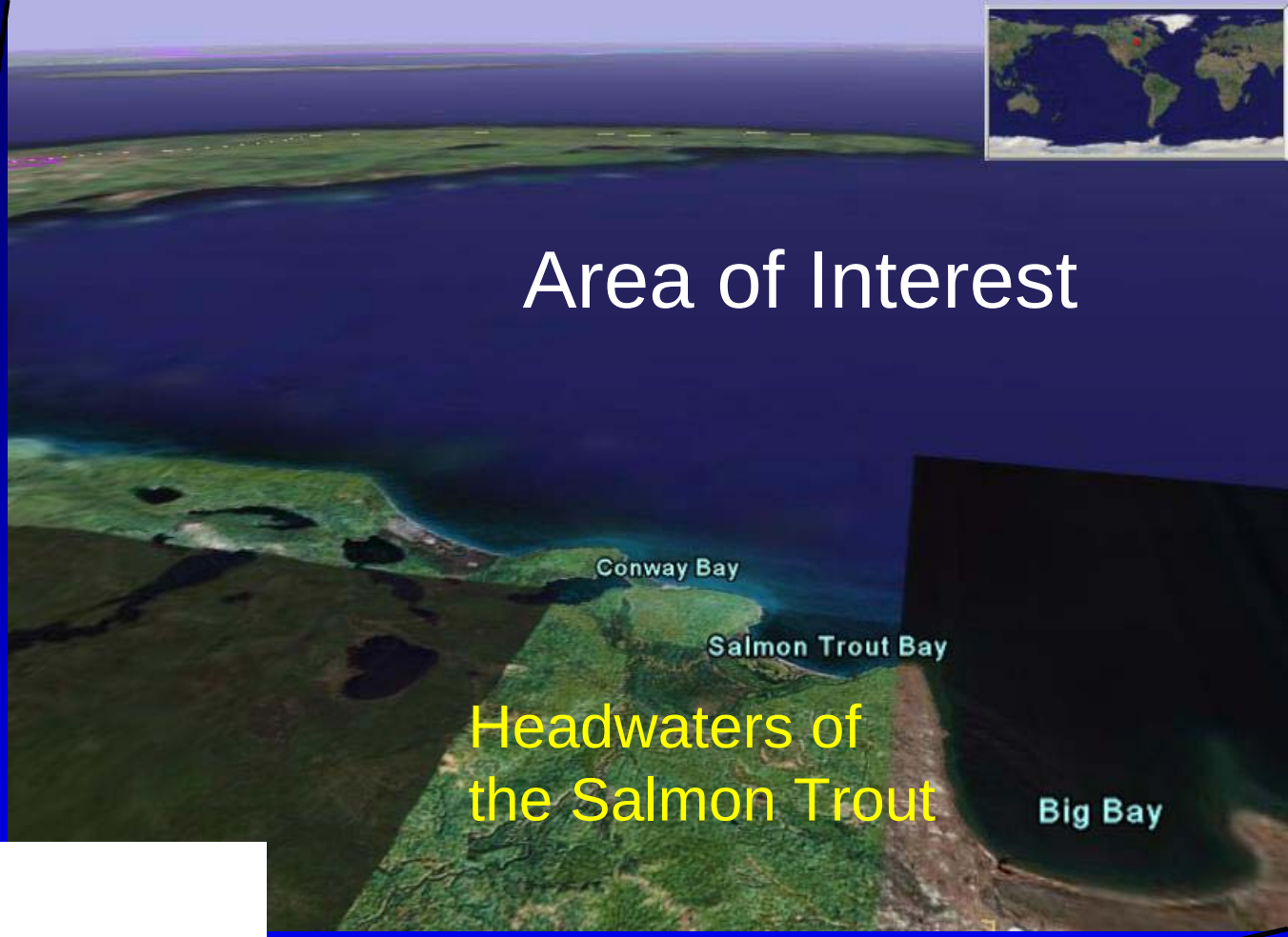
Expected disturbance-recovery trajectory

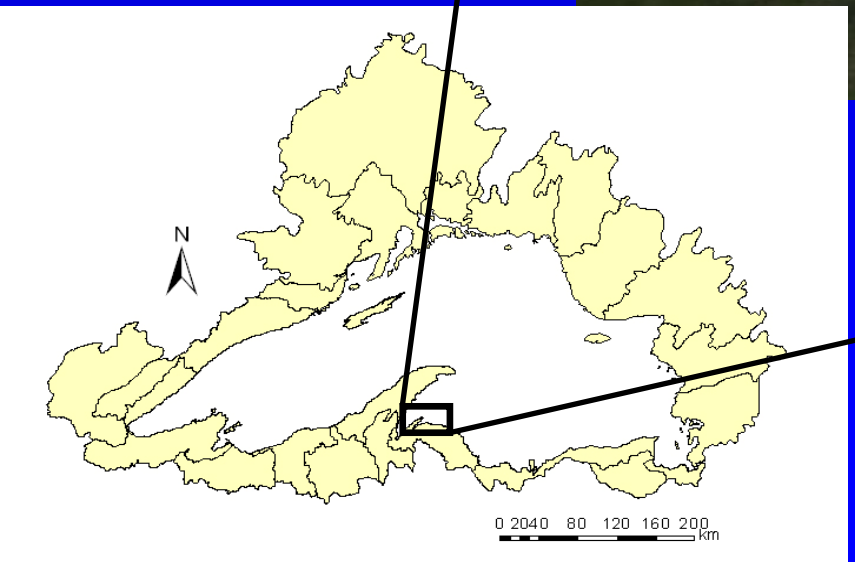
Single disturbance followed by second disturbance before recovery occurs

Single disturbance in a system already altered by disturbance

Paine et al. 1998

Lake Superior





Salmon Trout River